Two new species in the genus *Heteribalia* Sakagami (Hymenoptera: Ibaliidae) from China

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Abstract: The genus *Heteribalia* Sakagami (1949) is a member of the small parasitic wasp family Ibaliidae (Hymenoptera: Cynipoidea), and all known species of this genus are from China and its neighbouring countries. In this paper, we report two new species, *Heteribalia miltopronotum* sp. nov. and *Heteribalia sichuanensis* sp. nov., and distribution for *H. divergens* Maa (1949). These new discoveries update the known distribution of this genus in China from the known east coast areas to a much more extensive region between the eastern coast and Sichuan Province in central China. A key to all known *Heteribalia* species is provided.

Key words: Cynipoidea; taxonomy; key

中国异枝跗瘿蜂属分类研究及二新种记述（膜翅目：枝跗瘿蜂科）

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摘要：异枝跗瘿属隶属膜翅目瘿蜂总科，是寄生的枝跗瘿蜂科成员。该属目前分布于中国及邻近国家。本研究发现 2 新种：红背异枝跗瘿蜂 *Heteribalia miltopronotum* sp. nov. 和四川异枝跗瘿蜂 *Heteribalia sichuanensis* sp. nov.，报道了已知种 *H. divergens* Maa (1949) 的新分布区和生物学习性。并提供了该属的分种检索表。

关键词：瘿蜂总科；分类；检索表

Introduction

The genus *Heteribalia* Sakagami, 1949 is a small genus of the wasp family Ibaliidae (Hymenoptera: Cynipoidea) based on the species *Heteribalia nishijimai* from Japan. The genus was initially placed in the family Liopteridae (Sakagami 1949). Later in the same year, Maa (1949) described the genus *Myrmoibalia* Maa, 1949, based on a species from China,

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which that author placed in the family Ibaliidae. Weld (1952) synonymized the two genera with *Myrmoibalia* Maa, 1949 being a junior synonym of *Heteribalia* Sakagami, 1949, and placed this combined genus in the family Liopteridae. The taxonomic placement of *Heteribalia* by Weld (1952) was unchallenged until Ronquist and Nordlander (1989) suggested that this genus is a member of Ibaliidae as Maa (1949) originally contended. Liu and Nordlander (1994) included this genus in their taxonomic treatment of Ibaliidae supported by Ronquist (1995a) who conducted a comprehensive analysis of the phylogenetic relationships within the Cynipoidea. This provided strong support for the monophyly of Ibaliidae consisting of *Ibalia*, *Heteribalia*, and the monotype genus *Eileenella* Fergusson, 1992 from Papua New Guinea (Fergusson 1992).

The genus *Heteribalia* is easily separated from its sister genus *Ibalia* using the taxonomic key provided by Liu & Nordlander (1994), and a long series of autapomorphies has been identified for this genus by Ronquist (1995a) and Liu (1999) including: 1) the presence of a large, horizontally oriented prespiracular process anterior to the propodeal spiracle; 2) abdominal tergite 8 entirely covered by tergite 7; 3) bands or patches of dense pubescence present on abdominal tergites 4–7; 4) dorsal pronotal area large, at least 1/7 as long as mesoscutum along medial line; 5) mesotibia lacking anterior spur; 6) anterior flange of pronotum longitudinally strigate; 7) dense and long pubescence present on lateral propodeal carinae and posterolateral propodeal process; 8) coarse punctures present on abdominal tergites 5–7 in the female.

Five species of *Heteribalia* are currently known, including *H. nishijimai* (Sakagami 1949) from Japan (Hokkaido), *H. aureopilsa* (Maa 1949) and *H. divergens* (Maa 1949) from Eastern China, *H. subtilis* (Maa 1949) from the Taiwan island of China, and *H. confluens* (Maa 1949) from northern Vietnam (Liu & Nordlander 1994). The biology of this genus is largely unknown except that some individuals of *H. divergens* were reared from *Tremex fuscicornis* F. infested logs (Maa 1949).

In this study, we identify three *Heteribalia* species from China, including the previously described species *H. divergens* (Maa 1949) and two new species: *Heteribalia miltopronotum* sp. nov. and *Heteribalia sichuanensis* sp. nov. We have also updated the taxonomic key to species of this genus by Liu & Nordlander (1994) to include these new species. In addition, we report for the first time field observations of the ovipositional biology of *H. divergens* (Maa 1949).

Material and methods

All specimens examined are deposited at the Institute of Forest Protection, Zhejiang A&F University, Hangzhou, Zhejiang, China (ZAFU) except as otherwise indicated. All samples were examined with a Nikon SMZ800 stereomicroscope. To generate the images for external morphology, 15 photographs were taken for each frame at incremental focal distances with a Leica M205C compound stereoscopic microscope equipped with a confocal photographic system and the software platform Leica Application Suite 4.3.0 (Leica Microsystems Limited, Germany). The photographs were subsequently stacked using Helicon Focus Version 5.3.14 (Helicon Soft, Ukraine). All measurements were obtained using a Leica M205C stereoscopic microscope.

Field observations were made from mid-September through late October in 2010 and 2011, respectively, on the trunks of willow trees (*Salix babylonica*) grown as shade trees on the campus of Henan Normal University in Xinxiang City, Henan, China and along the nearby riverbank of the Weihe River. In order to rear the wasp and its hosts, wood infested with wood-boring insects was brought in to a lab on the Henan Normal University campus. Other tree species found on the sites included Koelreuteria paniculata (Sapindaceae), *Albizia julibrissin* (Fabaceae), *Sophora japonica* (Fabaceae), *Fraxinus chinensis* (Oleaceae) and *Sapium sebiferum* (Euphorbiaceae). Most field photographs were taken using a Samsung Digimax S500 camera (Samsung, South Korea) and a few were taken using a Canon PowerShot A495 (Canon, Japan).

Terminology for surface sculpture follows Harris (1979) and for skeletal structures follows Ronquist & Nordlander (1989) and Ronquist (1995b). All measurements are in millimeters. Abbreviations used are: F1 — first flagellomeres; Sc — subcosta; Rs2 — radial sector 2.

Results

1. ***Heteribalia divergens*** **Maa, 1949**

Myrmoibalia divergens Maa, 1949: 271.

Heteribalia divergens (Maa), Weld, 1952: 163.

Specimens examined. 2♀, **China,** Zhejiang, Hangzhou, Qihu CHEN, 04-XI-1957, 26-XI-1957. 2♀, **China,** Zhejiang, Yunhe, V-1955, Ronghua HUANG. 3♀, **China,** Zhejiang, Hangzhou, V-1962. 1♀, **China,** Jiangsu, 1976, Zhonglin ZOU. 1♂, **China,** Zhejiang, Lishui, Songyang, X-1994, Hanlin CHEN. 1♀1♂, collection data unknown.

Distribution. China (Zhejiang, Shanghai, Jiangsu, Henan).

The record from Henan Province is based on photographs taken in the field, which usually do not offer a definitive identification of small insect specimens. However, we are rather confident about the identification in this case owing to two factors, *i.e.*, individuals of this species are relatively large, ranging from 11–14 mm long, and the close-up photographs (*e.g.*, Fig. 1B) were sharp enough to reveal enough diagnostic features for relatively reliable identification.

Biology. Maa (1949) reported that specimens of *H. divergens* were reared from *Tremex fuscicornis* infested wood. In 2010 and 2011, we observed adults of this species to emerge and mate between September 20 and October 10. Females were observed to lay eggs between September 29 and October 20. The females, obviously already mated, would follow females of *Tremex simulacrum*, as the latter lay eggs into the trunk of willow trees (*Salix babylonica*). The willow trees observed to have these wasps were all alive, but very much stressed due to heavy infestation by various wood-boring insects, including *Anoplophora glabripennis* and *Megopis sinica* (Coleoptera: Cerambycidae) and *Tremex simulacrum* (Hymenoptera: Siricidae). Logs cut down from these trees and brought to the lab yielded only *A. glabripennis* and *M. sinica* beetles, and another species belonging to the Alleculidae. In addition, *Tremex simulacrum* females were also observed in the same locations to be followed by females of *Megarhyssa praecellens* (Hymenoptera: Ichneumonidae), one female of which was caught on camera to be apparently laying eggs in the exit hole of *H. divergens*. Of the roughly 1,000

wasps we counted, the *Tremex* host wasp, *Megarhyssa praecellens*, and *H. divergens* made up > 30%, > 60%, and ca 6%, respectively.

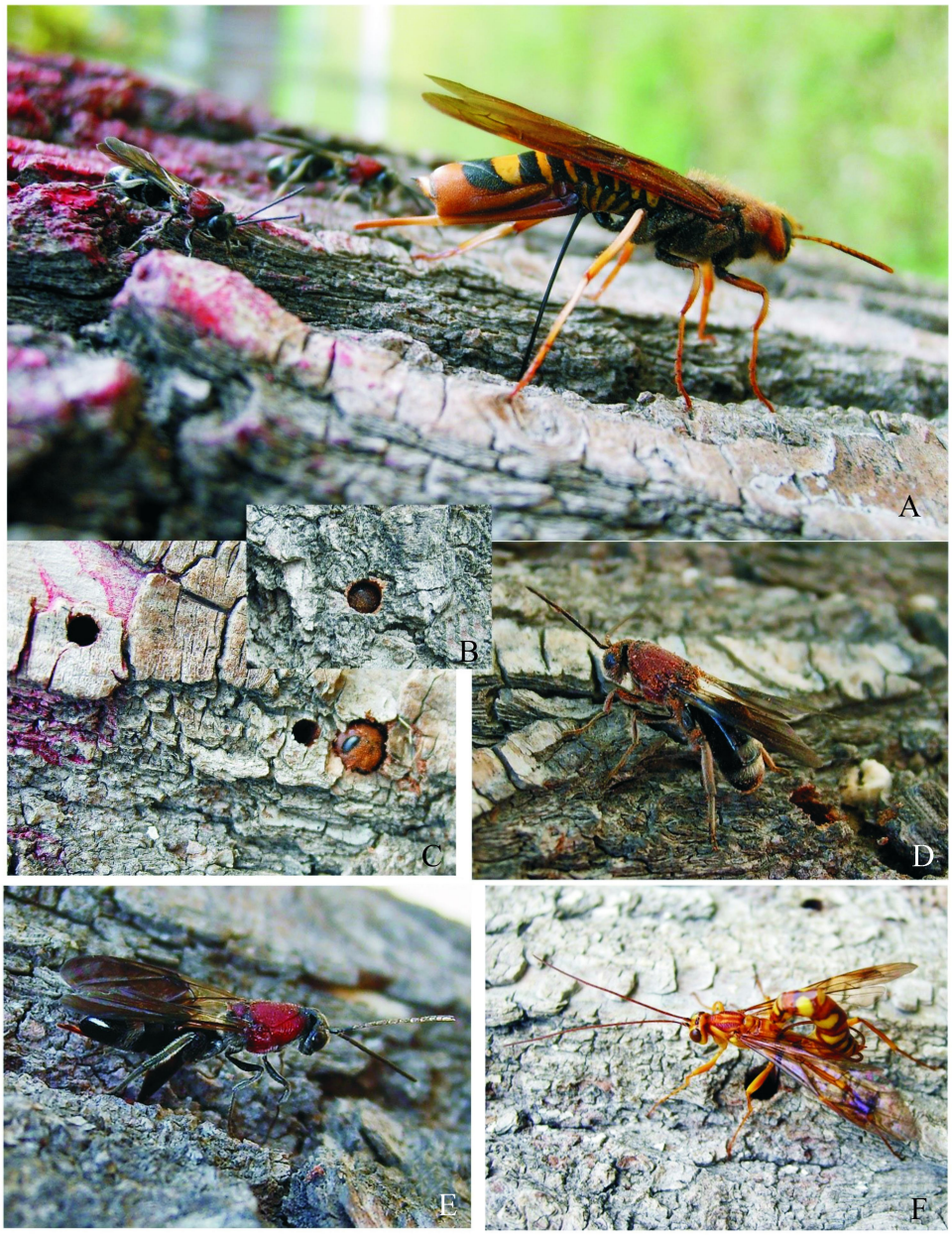


Figure 1. Biology of *H. divergens*. A. Females of *H. divergens* following a female of *Tremex simulacrum* as the latter lays eggs into trunk of a living willow tree (*Salix babylonica*); B. Emerging *H. divergens*; C. Emerging *Tremex simulacrum* beside an exit hole of *H. divergens*; D. Newly emerged male of *H. divergens*; E. Female of *H. divergens* laying egg; F. Female of *Megarhyssa praecellens* apparently laying egg in the exit hole of *H. divergens*.

2. ***Heteribalia miltopronotum*** **sp. nov.** (Figs. 2, 3)

Female. Body Length 11.67–12.71 mm (n = 3).

Coloration. Antenna, head, scutellum, metacoxa and metasoma black to dark brown. Pronotum reddish brown. Mesoscutum mostly dark brown and lighter-colored anteriorly; mesopleuron black. Coxae and trochanter dark brown, rest of legs brown. Wings evenly ferruginous.

Head (Figs. 2A, B). Vertex foveate-reticulate. Antennal scrobe slightly depressed. Upper face densely pubescent and punctate-foveate. Gena glabrate and densely punctate laterally. Occiput foveate-reticulate and punctate. Ratio of eye length to length of malar space about 2.6 : 1.

Antenna (Fig. 2C). Female antenna 13-segmented, relative length of each segment about 16 : 7 : 18 : 19 : 19 : 19 : 17 : 17 : 15 : 15 : 11 : 10 : 20. The region under the base of F1 is depressed.

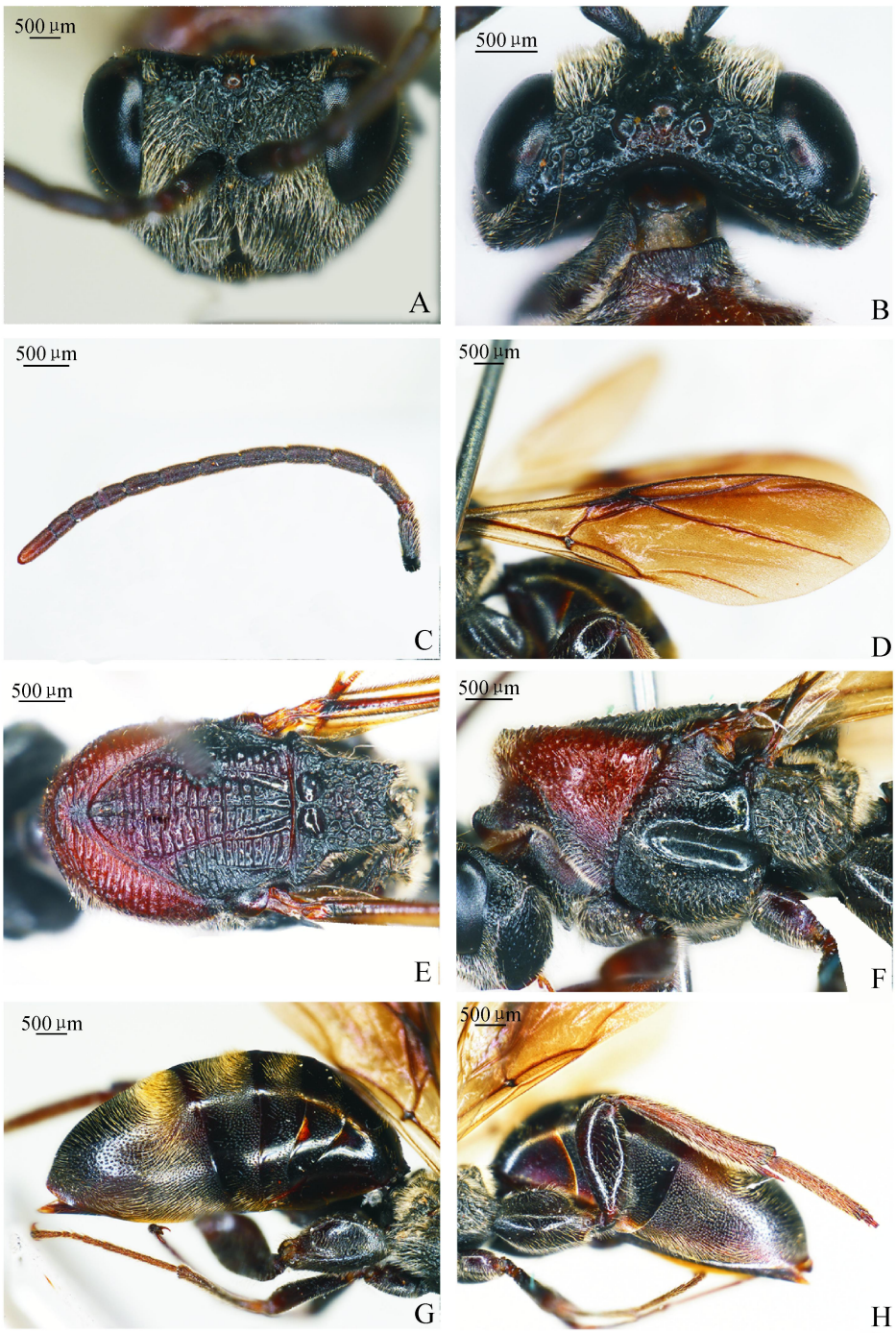
Mesosoma (Figs. 2E, F). Pronotal crest without medial incision; anterior flange of pronotum densely longitudinally strigate and sparsely pubescence. Pronotum with complete lateral pronotal carina; lateral pronotal area mostly glabrate and punctate, with obvious oblique strigate elements, especially on ventral half, and somewhat depressed along anteroventral margin (Fig. 2F). Mesoscutum conspicuously transversely costate; notaulus, median mesoscutal impression, and parapsidal furrows distinct. Scutellar foveae smooth and shining, separated by a strong median carina; mesoscutellum foveate-reticulate, with almost parallel lateral margins; posterior lateral processes short and blunt apically; distance between outer margins of posterior scutellar processes measured at base about 0.5 times greatest width of scutellum (Fig. 2E). Mesopleuron coarsely punctate; femoral groove shining, smooth and sparsely pubescent; mesopleural triangle shining, smooth and sparsely punctate; femoral groove prominent, glabrous and shining, smooth, with very fine pubescence; mesopleuron below femoral groove with dense long pubescence posteriorly. Metepisternum strongly punctate and rugose, with dense long pubescence. Propodeum entirely covered by dense tufts of long tinted hairs; prespiracular process prominent and smoothly rounded; lateral propodeal carina raised posterolaterally into a triangular process; median propodeal area with a simple longitudinal median carina and transverse carina at anterior 1/3.

Wings (Fig. 2D). Wings evenly ferruginous, except for slightly less ferruginous area at base. Areolet absent.

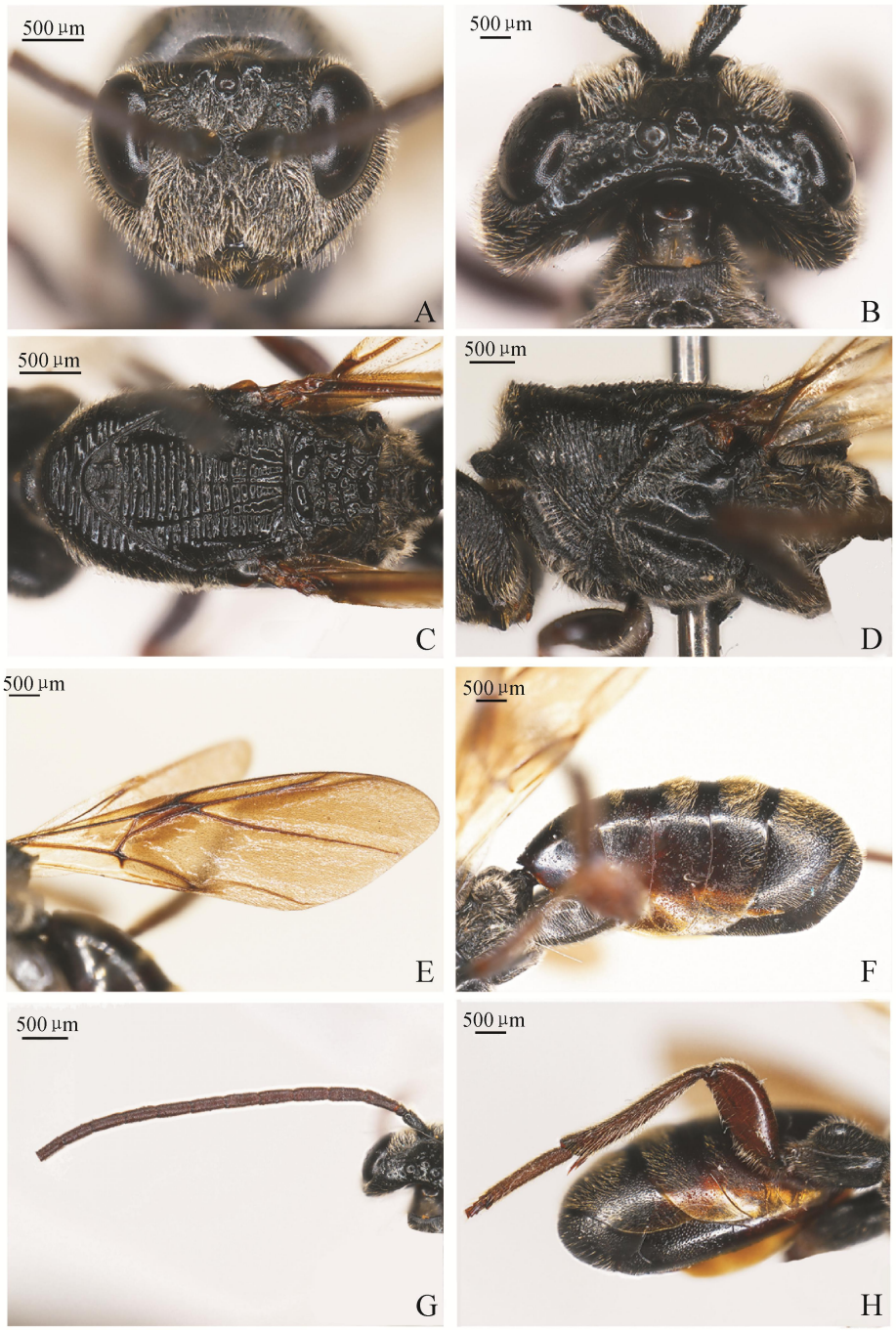
Legs (Fig. 2H). Metacoxa with distinct longitudinal groove and indistinct anterior lateral crest. Anterior apical process of 2nd metatarsomere reaching to base of 5th tarsomere.

Metasoma (Fig. 2G). Female metasoma 1.1 times as long as head and mesosoma combined; tergite 7 distinctly expanded to almost entirely cover barely visible tergite 8; tergite 7–9/10 as long as tergites 3–6 combined when measured laterally from tip to tip. Abdominal tergite 2 (petiole) small, crescent-shaped, and glabrous; tergite 3 mostly glabrous, except for a small dorsal patch of punctures and setae; tergites 4–6 extensively punctate dorsolaterally, except for a narrow posterior glabrous stripe on each tergite and tergite 7 entirely densely punctate; tergites 5–6 each with thick tuft of long golden pubescence dorsally and less prominent, but similar pubescence patch ventrally; tergite 7 entirely covered by long golden pubescence, forming a prominent tuft dorsally and an anterior band widened ventrally.

Male. Body length 11.0 mm.



Figures 2. *Heteribalia miltopronotum* sp. nov., ♀. A. Head, anterior view; B. Head, dorsal view; C. Antenna; D. Forewing; E. Mesosoma, dorsal view; F. Mesosoma, lateral view; G. Metasoma, lateral view; H. Femur, tibia and tarsus of hind leg.



Figures 3. *Heteribalia miltopronotum* sp. nov., ♂. A. Head, anterior view; B. Head, dorsal view; C. Mesosoma, dorsal view; D. Mesosoma, lateral view; E. Forewing; F. Metasoma, lateral view; G. Antenna; H. Tibia and tarsus of hind leg.

Coloration. Antenna scape, pedicellus, head reddish brown. Mesosoma black. Coxae and trochanter dark brown, rest of legs brown.

Head (Figs. 3A, B). Head transverse, frons striated, lower face densely pubescent. Malar space about 2.37 times as long as the scape.

Antenna (Fig. 3G). Flagellar diameter from base to apex gradually thinner.

Mesosoma (Figs. 3C, D). Pronotum uniformly transverse-striate, lateral side sparsely pubescence. Mesopleuron with the middle excavation broad, smooth and shining, anterior part sparsely pubescence, without punctures. Scutellum distinctly separated by a median carina, scutellar foveae sparsely punctured. The post-lateral tubercles prominent, but not longitudinally parallel.

Wings (Fig. 3E). Similar to female.

Legs (Fig. 3H). Similar to female.

Metasoma (Fig. 3F). Propodeum areolate, densely pubescence, median cavate area glabrous and shining. In dorsal aspect, abdominal tergite 3 without punctures and smooth, tergite 4–7 apical and lateral sides densely punctured and pubescent, the areas gradually increasing the extension from tergite 4 to tergite 7. Sternite 1–5 defined, not entirely concealed under the tergite.

Holotype. ♀, **China**, Jiangxi, Quannan, 24.42°N, 114.34°E, 11-VIII-2009, Shichang LI. **Paratypes**. 3♀1♂, same locality as holotype. 1♀, 27-VII-2009; 1♀, 18-VII-2009, 1♀, 02-IX-2009 (EIU Insect Collection); 1♂, 13-VI-2009.

Etymology. The species epithet of this new species is derived from Greek, *miltos* for red, referring to the red pronotum of this species.

Diagnosis. *Heteribalia miltopronotum* sp. nov. is similar to *H. nishijimai* and *H. confluens* in that the posterior end of abdominal tergite 7 is rounded, but differs from the latter two species in having scutellar foveae distinctly separated by a strong median carina and the pronotum of the female dark red. It can be further separated from *H. nishijimai* in: 1) pronotal crest is not incised medially, and 2) length of dorsal area of pronotum along median line is about 1/6, rather than 1/7, of the length of the mesoscutum. It can be distinguished from *H. confluens* in: 1) lateral surface of pronotum punctate and obliquely strigate, and 2) scutellum separated by a median carina.

3. ***Heteribalia sichuanensis* sp. nov.** (Figs. 4)

Female. Body length 13.54 mm.

Coloration. Antenna, head, pronotum anterior to lateral pronotal carina, a small median area of dorsal area of pronotum, scutellum, metathorax, and metasoma and legs dark brown to black; pronotum posterior to lateral pronotal carina, except for small median dark area in dorsal area, and mesothorax yellow brown (Figs. 4C, D). Eyes dark yellow. Wings tinted smoky gray.

Head (Figs. 4A, B). Vertex densely foveate and punctate. Antennal scrobe slightly depressed. Upper face coarsely rugose with sparse long hairs; median frontal carina interrupted by rough rugosity, but visible. Lower face entirely roughly rugose, slightly elevated medially, with obvious median carina reaching to clypeus, and except for median area, entirely covered with relatively dense long pubescence. Gena strongly pubescence, transversely costate, and punctate to foveate laterally. Vertex foveate reticulate. Occiput

glabrate, and punctate to foveate in upper part. Ratio of eye length to length of malar space about 2.1 : 1.

Mesosoma (Figs. 4C, D). Anterior flange of pronotum densely longitudinally carinate and sparsely pubescence; anterior plate of pronotum almost vertical, glabrous with sparse pubescence ventrally and coarsely punctate dorsally. Lateral pronotal carina strong and dorsally merged to pronotal crest; pronotal crest raised into a medially rounded process as high as the highest point of mesoscutum; dorsal area of pronotum shorter, 1/7 as long as mesoscutum measured along median line; dorsal and lateral areas of pronotum almost entirely transversely costate. Mesoscutum conspicuously transversely costate; notaulus conspicuous; anteroadmedian signum, median mesoscutal impression, and parapsidal signum distinct. Scutellar foveae large and separated by median longitudinal carina. Mesoscutellum coarsely rugulose and foveate to foveolate, sparsely pubescent laterally; outer margins slightly convergent posteriorly until reaching slightly divergent posterior scutellar processes; posterior margin broadly rounded. Mesopleuron mostly scabriculous with irregular striate elements, except for femoral groove and speculum; mesopleural triangle not well-defined ventrally; femoral groove deep, glabrous with sparse fine punctures and pubescence; speculum glabrous, posteriorly with sparse fine punctures; metepisternum coarsely scabrous; metapleural carina oblique, reaching to posterior margin of mesopleuron at upper 1/4; prespiracular process oriented obliquely and smoothly rounded dorsally. Lateral propodeal carina raised into a prominent process, acutely angular and apically rounded in lateral view. Median propodeal area covered by dense long pubescence.

Wings (Fig. 4E). Forewing with small areolet, vein R1 distinctly separated from vein Sc, dividing the usual cynipoid submarginal cell into a very narrow Sc cell and an Rs2 cell.

Legs (Figs. 4G, H). Anterior mesotibial spur distinct. Metacoxa dorsally with a deep longitudinal groove, laterally not forming an anterior lateral crest. Anterior apical process of 2nd metatarsomere nearly reaching to distal end of 4th tarsomere.

Metasoma (Fig. 4F). Female metasoma 1.3 times as long as head and mesosoma combined. Abdominal tergite small and crescent-shaped; tergite 3 glabrous with a dorsal patch of sparse setigerous punctures; tergites 4–6 with increasingly more extensive dorsal band of punctures and increasingly more distinct tufts of long pubescence; tergite 7 much expanded, as long as preceding 4 terga combined and covering tergite 8 completely, almost entirely densely punctate with a prominent anterodorsal tuft of long pubescence; posterior end of tergite 7 angular.

Male. Unknown.

Holotype. ♀, **China,** Sichuan, Leshan, Mt. Emei, 29.33°N, 103.21°E, 10-VII-1980, Junhua HE.

Etymology. This species is named after the type locality, Sichuan, a southwestern province of China.

Diagnosis. This new species is unique among all species in this genus in possessing a combination of two features that otherwise would readily divide the genus into two dichotomous groups, *i.e.*, 1) posterior processes of scutellum broad, triangular in dorsal view, and 2) posterior margin of abdominal tergite 7 of female not emarginated medially in dorsal view and apically angular in lateral view.

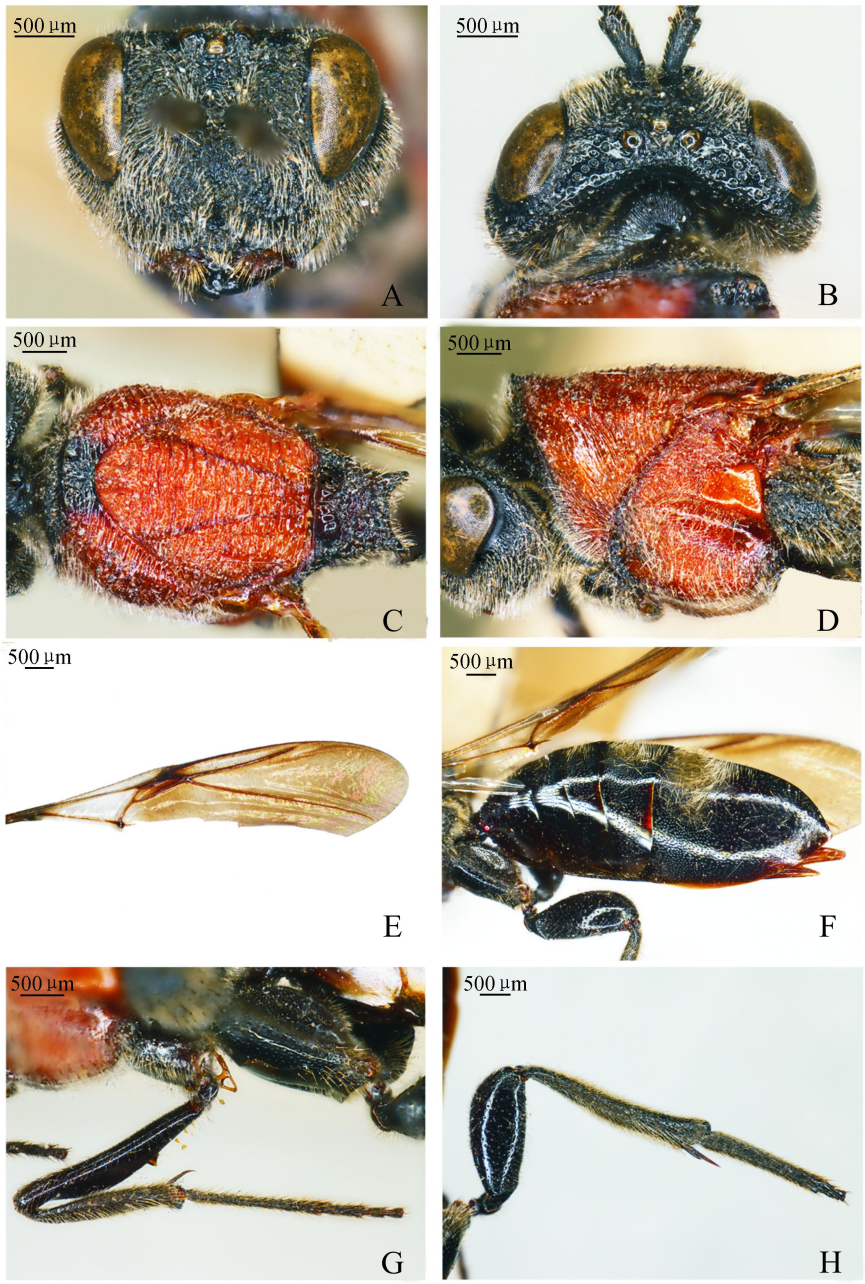


Figure 4. *Heteribalia sichuanensis* sp. nov., ♀. A. Head, anterior view; B. Head, dorsal view; C. Mesosoma, dorsal view; D. Mesosoma, lateral view; E. Forewing; F. Metasoma, lateral view; G. Mid leg; H. Hind leg.

Comment. Vein R1 of the type specimen is distinctly separated from vein Sc, dividing the usual cynipoid submarginal cell into a narrow Sc cell and an Rs2 cell. Although such a

condition has not been previously observed in Cynipoidea, it is premature to interpret its implication for venation evolution in the Cynipoidea before more specimens become available to clarify whether this is a condition found in just one individual specimen or a common condition for the species.

Key to known species of *Heteribalia* Sakagami, 1949

1. Posterior processes of scutellum broad, triangular in dorsal view ·····2
-. Posterior processes of scutellum mostly narrow, tubular in dorsal view·····5
2.Posterior margin of abdominal tergite 7 of female not emarginated medially in dorsal view and apically angular in lateral view (Fig. 4F). ·····*H. sichuanensis* **sp. nov.**
-. Posterior margin of abdominal tergite 7 of female visibly emarginated medially in dorsal view and apically rounded in lateral view (Fig. 2G). ·····3
3. Scutellar foveae distinctly separated by median carina····· *H. miltopronotum* **sp. nov.**
-. Scutellar foveae confluent, not separated by median carina·····4
4. Pronotal crest distinctly incised. Median area of propodeum smooth and shining····· *H. nishijimai* Sakagami
-. Pronotal crest not incised. Median area of propodeum transversely striated·····*H. confluens* (Maa)
5.Scutellum usually dark brown to dull red. Abdominal tergum 7 of female as long as preceding 4 terga combined or slightly longer than preceding 4 terga combined····· *H. divergens* (Maa)
-. Scutellum usually red to dark red. Abdominal tergum 7 of female distinctly shorter than preceding 4 terga combined····· 6
6. Median length of dorsal pronotal area about 0.22 times length of mesoscutum. Prespiracular process on metapleuron black and low·····*H. subtilis* (Maa)
-. Median length of dorsal pronotal area about 0.16 times length of mesoscutum. Prespiracular process of metapleuron red and highly raised.····· *H. aureopilosa* (Maa)

Discussion

The genus *Heteribalia* was previously known to be limited to the easternmost rim of the Palaearctic and North Oriental regions (Nordlander *et al*. 1996). Discovery of *H. miltopronotum* and *H. sichuanensis*, as well as the discovery of *H. divergens* from several new locations, have extended the distribution to the interior of continental China (Fig. 5). Nonetheless, these discoveries are not contradictory to the proposition that this genus has originated and diversified in this area Eastern Asia (Nordlander *et al*. 1996). The study of the phylogenetic relationships within Ibaliidae by Nordlander *et al*. (1996) placed *H. nishijimai* Hokkaido, Japan and *H. confluens* from northern Vietnam in a monophyletic clade to the stem species of the other species. These authors considered the lack of any *Heteribalia* species in the large area separating Northern Japan and Vietnam was due to either extinction or lack of knowledge about the genus in this intermediate area. This present study provides support for the latter view and future studies may lead to the discovery of more species of this unique genus in the subtropical and temperate hardwood forests throughout the region (ECVC 1980).

The distribution of *H. divergens* is, as is currently known, limited to the northern subtropical to temperate areas of eastern China, but could potentially be more widely distributed, given the fact that the known *Tremex* host species are widely distributed. *T. fuscicornis* is native throughout the Palaearctic from Europe to Japan (Schiff *et al*. 2012) and *T. simulacrum* is widely known from eastern China from Heilongjiang Province in the north

(Yang & Gu 1994), Shanxi Province in the west, and to Zhejiang Province in the south (ECFISP, He 2004).

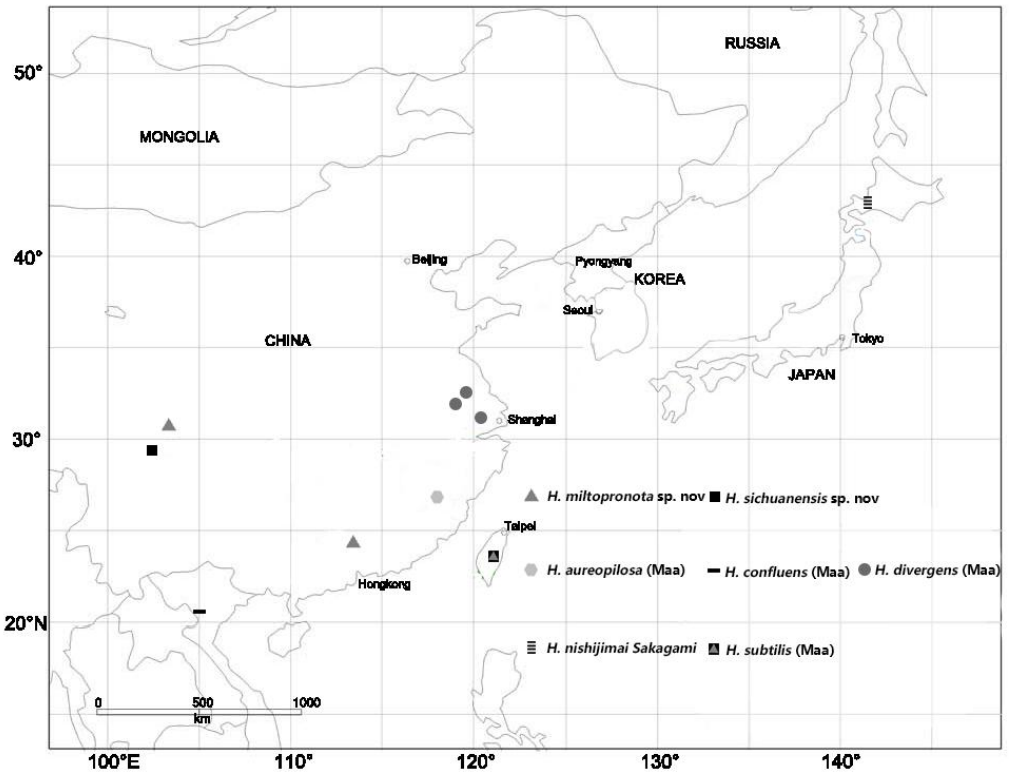


Figure 5. Distribution of known species of *Heteribalia* Sakagami, 1949.

The biology of this genus was previously largely unknown except for rearing data, which showed *H. divergens* to be associated with *Tremex fuscicornis* (Maa 1949). In this study, we were able to observe females of *H. divergens* follow egg-laying females of *Tremex simulacrum*, as the latter oviposited into the trunk of willow trees. Females of *Ibalia* insert their terebra through the oviposition shafts made by the siricid females and oviposit into mature eggs or young larvae of the host (references in Liu & Nordlander 1994). It is possible that *H. divergens* females also make use of the *T. simulacrum* oviposition shaft to place their eggs on the host, but that needs to be confirmed.

The willow trees observed with *H. divergens* wasps were very much stressed due to heavy infestations by various wood-boring insects, including, in addition to *T. simulacrum,* two cerambycid beetles *Anoplophora glabripennis* and *Megopis sinica* (Coleoptera: Cerambycidae) and another beetle species belonging to Alleculidae. In addition, a large number of *Megarhyssa praecellens*, a parasitoid species of woodworking insects, also followed egg-laying females of *T. simulacrum.* One female was caught on camera to apparently be laying eggs in the exit hole of *H. divergens*. Several intriguing aspects about the relationship of *H. divergens* with the other species in this community need to be further clarified, such as whether *H. divergens* also use the beetle species as host and whether *Megarhyssa praecellens* behaves as a facultative hyperparasitoid of *H. divergens.*

It is notable that *H. divergens* were seen in relatively high numbers on our field sites, and this species might be much more abundant, given that there were a high number of fresh exit holes apparently belonging to this species (Figs. 1B–D, F). Because *T. fuscicornis* has been accidentally introduced into Chile in South America and has become a most destructive pest of black poplar (*Populus nigra*) and also attacks *Robinia pseudoacacia* and *Acer negundo* (Schiff *et al.* 2012), it may have the potential to be used as an effective biological control agent in the future, a role that its close relative *Ibalia leucospoides* has played in the control of *Sirex noctilio* in Australia and several other countries in the southern hemisphere (Liu & Nordlander 1994; Cameron 2012).

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